REMARKS

Claims 1-19, 21-33, 39, 40, 43 and 44 are pending in the present application; claims 34-38 having been withdrawn and claims 3, 13, 20, 41 and 42 have been cancelled.

Amendments to the Drawings

No amendment is necessary.

The drawings are objected to on the ground that the feature recited in Claim 33 has not been shown. Claim 33 has been amended to clarify that the substrate layer is separated from the active layer by portions of the first and second structures. Such configuration is clearly shown in Fig. 2. As explained in paragraph **[0020]** in reference to Fig. 2, the hole etching or drilling in the photonic crystal structure can even punch holes through the active layer 121 and wave guide layer 123 as indicated by dotted line 203. Therefore, portions of the photonic crystal structure and wave guide layer 123 are located between the active layer 121 and the substrate layer 110. For this reason, it is believed that no drawing corrections are necessary.

Claim Rejections under 35 U.S.C. 112 and Objection to the Specification

Claim 20 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement.

Claim 30 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement.

Claim 5 recites the limitation "the at least one semiconductor layer" in line 2.

The specification is objected to for not disclosing the subject matter of Claim 33. As explained above, the subject matter of Claim 33 as amended is clearly disclosed in the specification so that no amendment to the specification is necessary.

Claims 20 and 30 are rejected under 35 USC 112, first paragraph. Claim 20 has been cancelled. Claim 30 has been amended to recite the range from 1 micron to 100 microns as disclosed in paragraph **[0022]**. Therefore, the rejection of claim 30 under 35 USC 112 is believed to have been overcome.

Claim 5 has been rejected for lacking antecedent basis. Claim 5 has been amended so that the limitation objected to is no longer present.

Thus all of the presently pending claims are believed to comply with 35 USC 112.

Claim Rejections under 35 U.S.C. 102 and 103

Claims 1-4, 6, 31, 32 and 39-41 are rejected under 35 USC 102(b) as being anticipated by U.S. Patent 5,970,081 to Hirayama et al. The rejection is traversed insofar as it is applied to the claims as amended.

Claim 1 has been amended to specify that the device claimed is a light emitting diode device, which is quite different from the laser device of Hirayama. The active layer of Claim 1 generates incoherent light whereas Hirayama's layer generates coherent light. Claim 1 has also been amended to specify that a photonic crystal structure is in the second structure used for extracting the light trapped.

It is well settled that in order for a reference to anticipate a claim, there must be identity of elements between those of the reference and those of the claim. Since Hirayama clearly fails to teach or suggest a light-emitting diode device and the use of photonic crystal structure in the second structure for extracting the light, there is no identity of elements between Hirayama and Claim 1 so that Hirayama fails to anticipate Claim 1 as amended.

Claim 1 has been amended to incorporate the features of claim 13, and claim 13 has been cancelled. The Examiner is of the opinion that Claim 13 is rendered obvious over Hirayama in view of U.S. Patent 5,995,749 to Joannopoulos under 35 USC 103(a). We disagree.

In Hirayama, the coherent light generated by the active layer 113 becomes guided-mode light in the form of forward and backward waves R and S shown in Fig. 14B which are guided along the wave guide stripe 120 in opposite directions. The wave guide stripe 120 of Hirayama has a constricted shape at the center which functions as a phase shift means for shifting the phase of the diffraction grating 115. The narrow portion of the wave guide stripe 120 is arranged in a substantially symmetrical distribution shape over a region longer than the period of the diffraction grating 115. This constricted portion of the wave guide is such that the R and S waves interfere with each other so as to intensify each other at the center portion of the radiation-mode light, and interferes so as to weaken each other at the two side portions of the radiation-mode light. *See* Hirayama column 6, lines 18-39. Since there is no radiation-mode from the two

ends, more efficient emission is possible at the central portion of the radiation-mode light to obtain an output of 15 milliwatts. Column 6, lines 55-63.

As noted from the description above, the wave guide of Hirayama not only is used for containing the forward and backward waves RS, but also as a phase shift means by means of the constricted portion in the center of the wave guide. This constriction must be set so that the two waves R and S interfere to intensify each other at the center portion of the radiation-mode lights and weaken at the two side portions. This constriction is then used to shift the phase of the diffraction grating 115.

From the above, it is clear that the constriction and wave guide stripe 120 is used specifically by Hirayama as a phase shift means for shifting the phase of the diffraction grating 115. It is simply not clear whether this constriction will have the same effects on the photonic crystal of Joannopoulos, which in the opinion of the Examiner, can be substituted for the grating. As noted above, this phase shift means in the wave guide 120 has a very specific function: causing the forward and backward waves RS to interfere so as to intensify at a central portion of the radiation-mode lights to be extracted by the diffraction grating. It is simply not clear at all what effect this restriction will have on the photonic crystal of Joannopoulos, and the Examiner has failed to explain how it will.

Furthermore, in view of the vast differences between the devices of Hirayama on one hand and Joannopoulos on the other, there appears to be no reason or motivation for making the combination as urged by the Examiner.

As noted above, the active layer of Claim 1 generates incoherent light whereas that of Hirayama generates coherent light. Since the light generated by Hirayama is coherent, it is possible for Hirayama to generate and confine light traveling in two opposite directions. It is then also possible for Hirayama to employ the constriction in wave guide 120 as a phase shift means for shifting the phase of the diffraction grating 115. The light generated by the active layer in Claim 1, on the other hand, is incoherent so that the wave guide layer in Claim 1 does nothing more than confining and concentrating the energy of the light, such as into a single or a few lower-order optical modes. Since the light trapped within the wave guide layer is incoherent, it is not meaningful to employ any phase shift means such as one used by Hirayama. The light trapped in the wave guide layer of amended Claim 1 also is not in the form of two waves traveling in opposite directions. Instead, the light propagating in the wave guide layer of

amended Claim 1 can be in any direction. This difference has important consequences for the device. In order for the wave guide 120 with the constriction and the diffraction grating 115 to function as described by Hirayama, the diffraction grating must be placed in the orientation shown in the figures of Hirayama, such as where the plane of the grating is parallel to the plane of the wave guide. If the grating is oriented in a direction different from that shown, they will fail to extract light from the wave guide 120. This is not the case at all with the photonic crystal structure in amended Claim 1. In contrast to the diffraction grating which is a one-dimensional structure, a photonic crystal is a two-dimensional or three-dimensional structure and is able to extract light propagating in the wave guide in any direction.

Another important difference between the device of amended Claim 1 and Hirayama is the direction of the light output from the device. As a laser device, Hirayama would want to emit light as a coherent laser beam in a particular direction. This is achieved by using the diffraction grating 115 as the means for extracting the lights. The direction of the light extracted would be in a direction perpendicular to the plane of the diffraction grating 115. In contrast, since the device in Claim 1 is a light-emitting diode type, it would be undesirable for the light emitted to be in the form of a beam along a single direction; instead, it is desirable for the light to be emitted in different directions, such as for lighting purposes. Photonic crystal structure serves this purpose by extracting the light and emitting the light extracted in different directions, rather than in a single beam along a single direction, in contrast to the diffraction grating 115 of Hirayama.

As noted above, Claim 1 has been amended to incorporate essentially the limitations of Claim 13. Claim 13 is rejected under 35 USC 103(a) as being unpatentable over Hirayama in view of Joannopoulos. The rejection is traversed insofar as it is applied to amended Claim 1. In regard to the limitation of Claim 13, the Examiner is of the opinion that "in the art of light extraction from light emitting devices it would have been obvious to include set further limitation in view of Joannopoulos who teach a layer of photonic crystal cells 22 (Abstract, Fig. 2A and column 4, lines 55-67) . . . to enhance extraction of radiation from said light emitting device . . . . Motivation immediately derives from the resulting improved extraction efficiency taught by Joannopoulos (column 2, lines 7-18), which also is a major objective of Hirayama (see e.g., the Abstract)."

We do not believe that there is an established art known as the "art of light extraction" from light emitting devices, and the Examiner has failed to give any factual basis for this characterization. Instead, different types of light-emitting devices may require different types of light extraction techniques, so that what may be applicable to one type of light-emitting device may not work for another type. As seen from the description of Hirayama above, for example, what may work as a light extraction technique for a laser type device such as Hirayama may not work or be desirable for a light-emitting diode. Furthermore, given the special requirements and interaction between the constricted wave guide layer and the diffraction grating of Hirayama, there is no assurance that replacing the diffraction grating of Hirayama by the photonic crystal of Joannopoulos will result in improved extraction efficiency, or even as intended by Hirayama. As noted above, the Examiner has failed to provide any factual support for his assertion.

Furthermore, not all light-emitting devices can be lumped together in one general category. As noted above, there is a vast difference between a laser type device such as Hirayama and a light-emitting diode type device such as that of amended Claim 1 and of Joannopoulos. As noted above, in a laser type device such as Hirayama, the light emitted is coherent and so is the light within the laser. In contrast, the light generated and trapped within a light-emitting diode type device such as that in amended Claim 1 and Joannopoulos is incoherent. It is feasible and sometimes important such as in Hirayama to adjust the phase of the coherent light trapped in the laser such as in Hirayama, whereas in light-emitting diode type devices such as in amended Claim 1 and Joannopoulos, it is generally not useful or even meaningful to perform phase shifting. As also noted above, a laser type device such as Hirayama's would want to emit light as a coherent beam in a single direction whereas in light-emitting diode type devices such as in amended Claim 1 and Joannopoulos, this is generally undesirable. Given the above vast differences between laser type devices and light-emitting diode type devices, there appears to be no reason or motivation for combining Joannopoulos and Hirayama in a manner urged by the Examiner. As noted above, the reasons or motivations set forth by the Examiner appear to lack factual basis and are not convincing.

The Examiner's position appears to be contrary to the court's ruling in *In re Sang Su Lee*, 277 F.3d 1338, 61 U.S.P.Q.2d 1430 (Fed. Cir. Jan. 2002). In such case, the Federal Circuit, quoted *In re Dembiczak*, 175 F.3d 994, 999, 50 U.S.P.Q.2d 1614, 1617 (Fed. Cir. 1999) as follows: "Our case law makes clear that the best defense against the subtle but powerful

attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references." The Federal Circuit went on to state that "The need for specificity pervades this authority . . . . The Examiner's conclusory statements . . . do not adequately address the issue of motivation to combine. This factual question of motivation is material to patentability, and could not be resolved on subjective belief and unknown authority."

In re Sang Su Lee addresses the issue of the lack of motivation to combine prior art references. The same rule is believed to be applicable here where the rejection is based on combining two references. As noted above, there is no factual support for the Examiner's assertions. The obviousness rejection fails for the many reasons explained above. The combination of the two references (Hirayama and Joannopoulos) is therefore based only on subjective belief and unknown authority. As pointed out by the Federal Circuit in the *In re Sang Su Lee* case, under the Administrative Procedure Act, the Patent Office is required to develop an evidentiary basis for its findings and its omission is both legal error and arbitrary agency action. Therefore, the Examiner has failed to provide adequate evidentiary basis for its factual findings and failed to prove a *prima facie* case of obviousness with respect to claim 1.

It is worth noting that combining a waveguide structure in non-coherent LED with photonic crystal structure as in claim 1 is not an obvious approach at all in light of art such as Hirayama and Joannopoulos. Waveguide structure is generally viewed by those in designing LEDs as a structure that is counter-productive for light extraction in conventional LEDs. However, when it is paired with a photonic crystal structure as in claim 1, the extraction becomes more effective because photonic crystal is able to interact more effectively with more confined light such as that propagating in a waveguide.

For the reasons given above, amended claim 1 is believed to be allowable over Hirayama and Joannopoulos either individually or in combination. Claim 39 is believed to be allowable for similar reasons.

Allowable Subject Matter

Claim 33 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form.

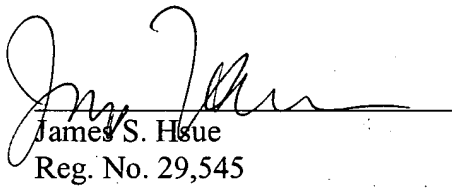
The indication that Claim 33 would be allowable if written in independent form and if the lack of disclosure objection is overcome. As noted above, Claim 33 has been amended to overcome the lack of disclosure objection. It has also been rewritten in independent form. Claim 33 is therefore believed to be allowable.

CONCLUSION

Claims 2, 4-12, 14-19, 21-32, 40, 43 and 44 are believed to be allowable since they depend from allowable claims.

In view of the amendments and remarks contained herein, it is believed that all pending claims are in condition for allowance and an indication of their allowance is requested. However, if the Examiner is aware of any additional matters that should be discussed, a call to the undersigned attorney at: (415) 318-1162 would be appreciated.

Respectfully submitted,



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